MEMORANDUM
INTERMOUNTAIN POWER SERVICE CORPORATION
INTERMOUNTAIN GENERATING STATION

MEMO BY: Phil Tice TO: Dennis Killian

DATE: November 4, 1987 FILE NO: 43.2600

SUBJECT: Follow up report regarding Cooling Tower Fan Blade Resonance

Please find attached a report detailing the results of blade movement while cooling tower fans are in operation. The report also contains a discussion regarding the ten bladed fan proposed by Ceramic.

cc:Gary Rose

MEMORANDUM
INTERMOUNTAIN POWER SERVICE CORPORATION
INTERMOUNTAIN GENERATING STATION

MEMO BY: Wes Bloomfield TO: Phil Tice

DATE: November 3, 1987 FILE NO:

SUBJECT: Follow up Report Concerning the Cooling Tower Fan Blade Resonance and Ceramic Cooling Towers Proposed use of a Ten Blade Fan System

REFERENCE: Letter, dated January 29, 1987, Resonance of Cooling Tower Fan Blades may be causing fan failures.

Several months ago a very sophisticated vibration test was performed on cooling tower fan 1A03. The results of the test showed that the cell stack design is exciting the blades at their natural resonance component. Ceramic's proposed use of a ten blade fan system will not effect this resonance problem, however the overall influence may be lessened.

Fan cell 1A03 was selected for this special vibration test because of several tripping problems due to a blade droop switch being activated. Acceleration probes were mounted at the end of three of the seven blades, (see picture #1). A cable was then run from the probe to a recorder and power system, which were mounted in the center of the fan hub, (see pictures 2 thur 5). A key phaser was also attached to the fan hub and referenced to a point on the gear reducer. With this unique setup, vibration data concerning the blade movement could be obtained while the fan was in operation.

The data gathered first was the result of a fan static condition, while air was short circuited through the dormant cell. As attachment 1 indicates the three blades were being excited at natural blade resonance, 412 cpm. Attachment two indicates the signal waveform of the three blades as the fan was in operation. The waveforms have been integrated from acceleration to velocity with the ADRE 3 Data Acquisition System. All values indicated in these plots should be multiplied by a factor of 10. Attachment 2 indicates very clearly that each blade was being excited four times during each revolution. Other minor spikes in the waveform indicate reaction to other blades moving in the fan system, thus creating a fan hub wobble. Signature traces, cascade plots, and careful attention to the key phase reference mark in attachments 3 - 6, bear this last comment out. The probe on blade # 5 was damaged shortly into the test, so data was not available.

After this last test was performed, Ceramic removed any blades which were considered to be at risk (blades with wrinkles in the neck). Since this work was performed, there has not been another failure on Unit 1. If failures should again begin to occur, then blades should be stiffened with the addition of foam to the inter void. This has been determined by Ceramic and Hudson Fan as the most economical and effective fix for the problem.

Ceramic's proposed use of a ten blade fan system to improve performance will not effect the blade resonance. The addition of three blades will however, lesson the reaction of the other blades moving in the cell. This occurs because a blade losing load will be counteracted by a blade on the opposite side of the fan losing load at the same time. Thus the overall fan wobble will be lessened. Signatures gathered from cells 2A09, 2A10, and 2A12, newly installed ten blade systems, bear this out.

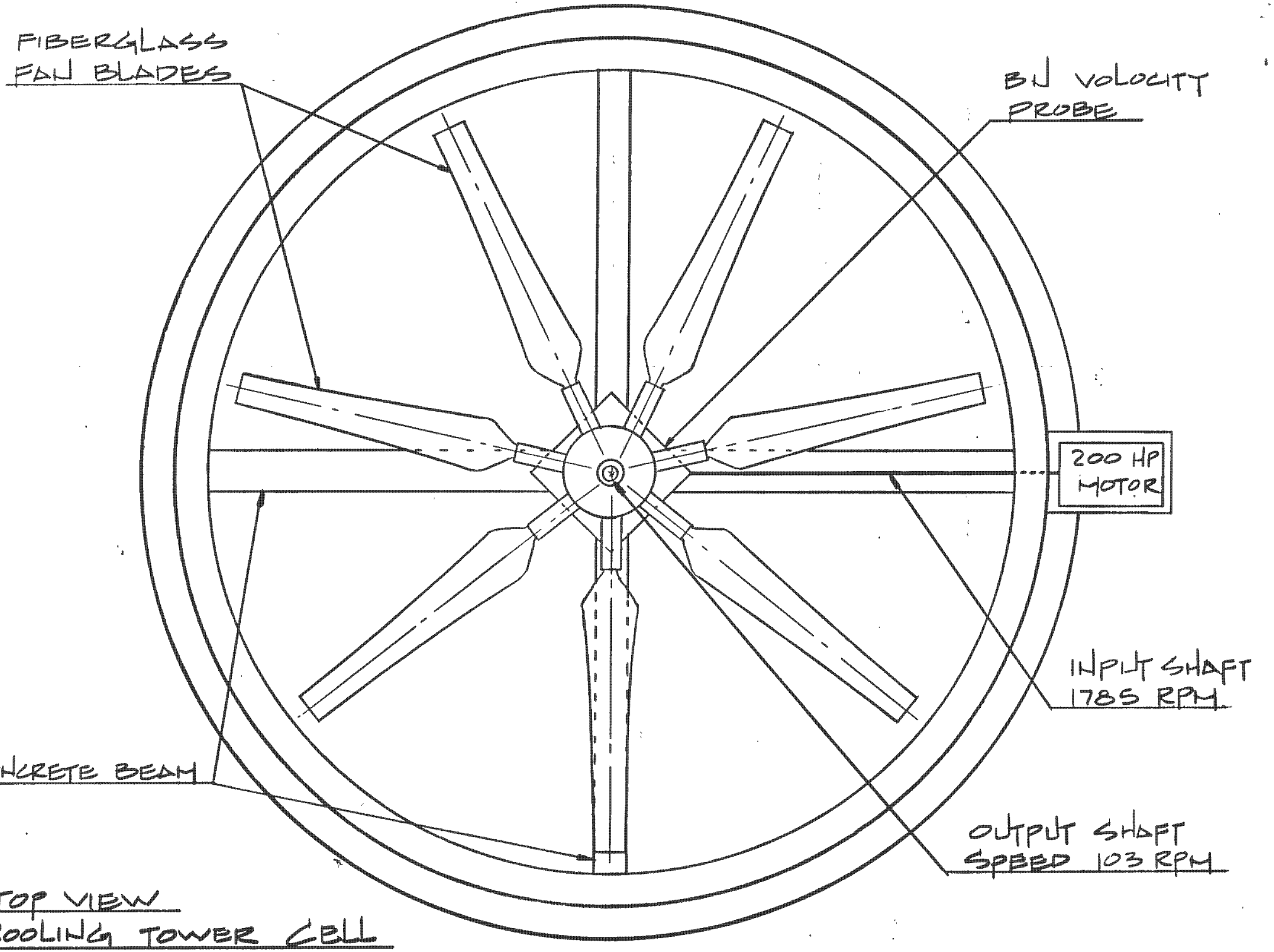
In Conclusion, the blade resonance problem referenced in earlier reports has been substantiated as being a contributor to the blade failures. If more failures should occur, then stiffening the blades by the addition of foam in the inter void of the blade should correct the problem. Ceramic's use of the ten blade system will have no effect on the blade resonance but will lesson the fan hub wobble experienced by the seven blade system. If you should require further information please contact me at extension 6483.

Sincerely,

Wes Bloomfield

Wes Bloomfield
Reliability Engineer

attachments



TOP VIEW
COOLING TOWER CELL

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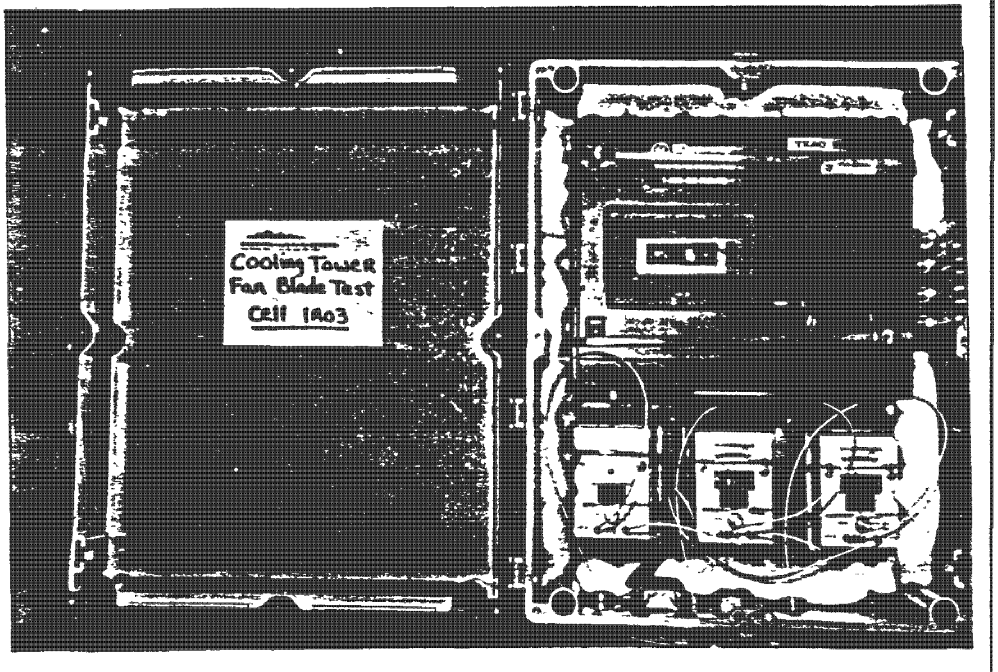
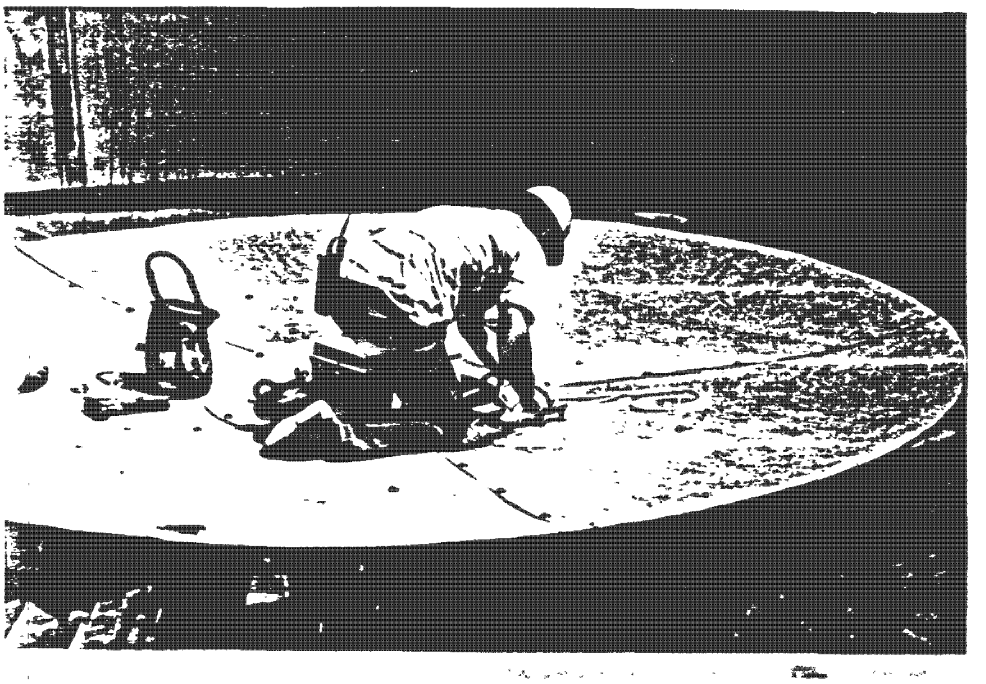
PICTURE # 1

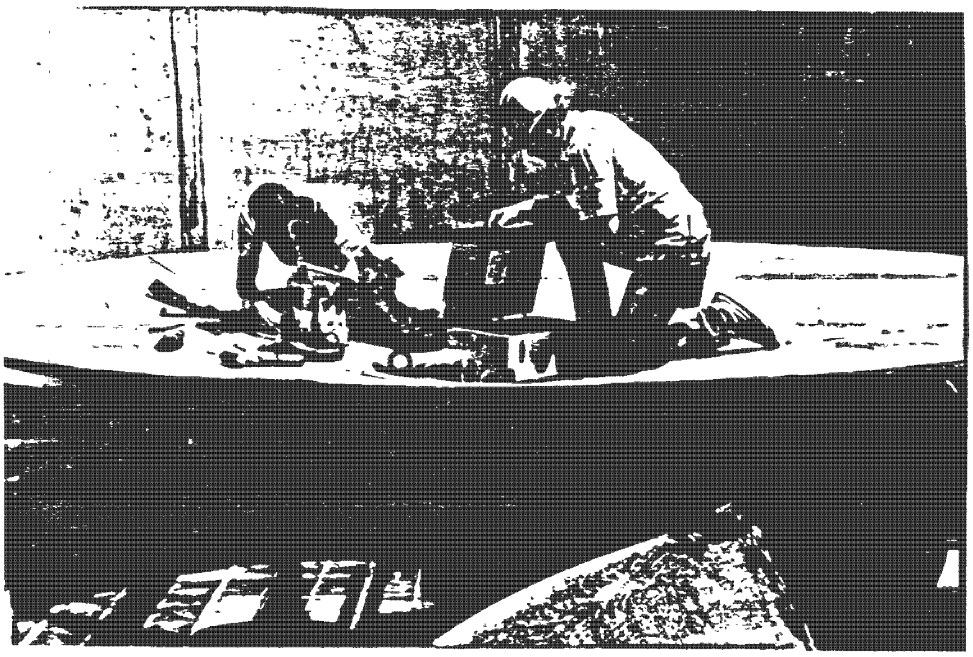
PICTURE # 2



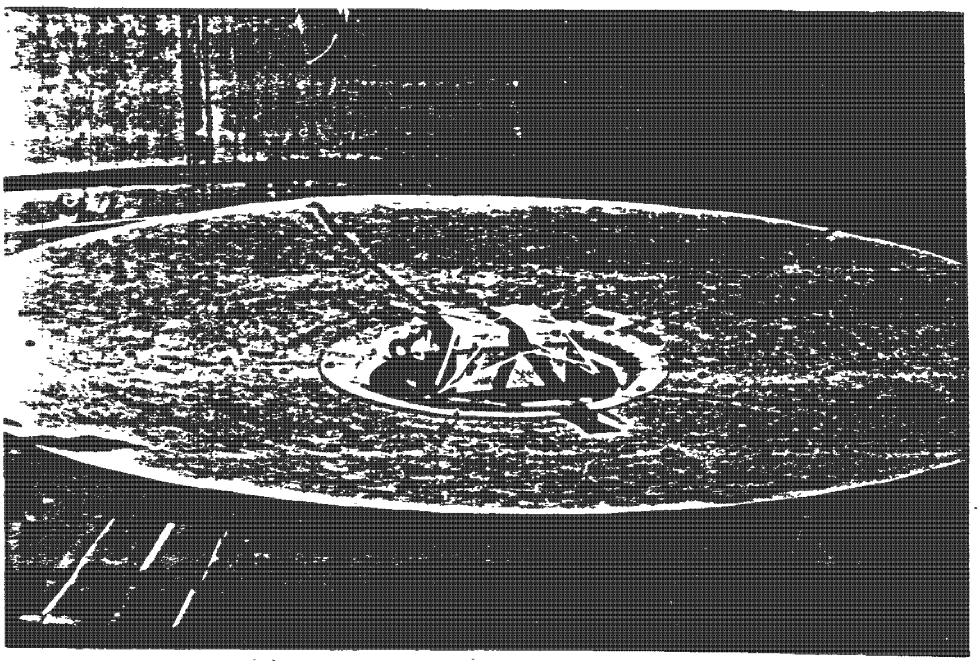
PICTURE # 3



PICTURE # 4



PICTURE # 5

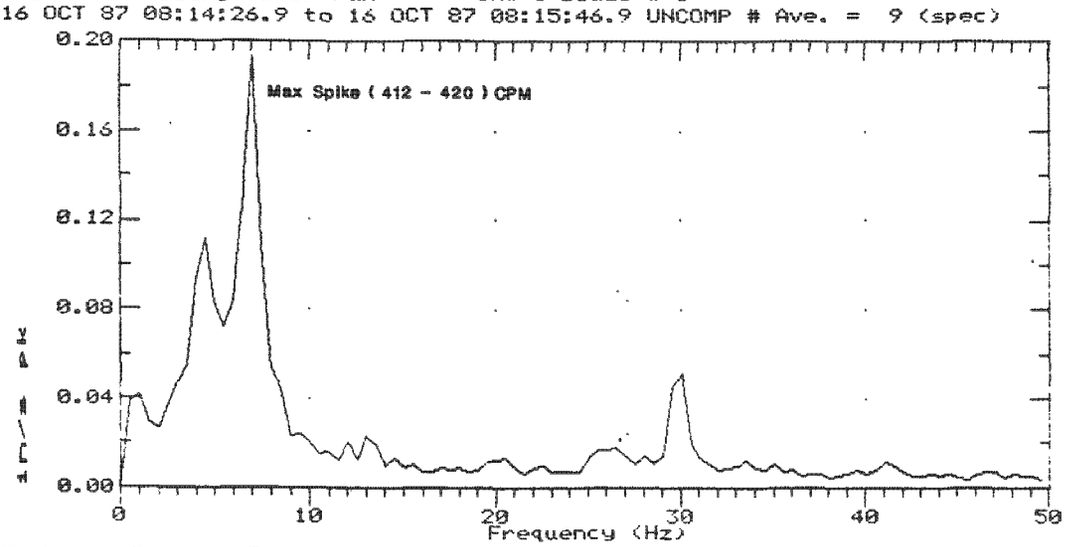


ATTACHMENT # 1

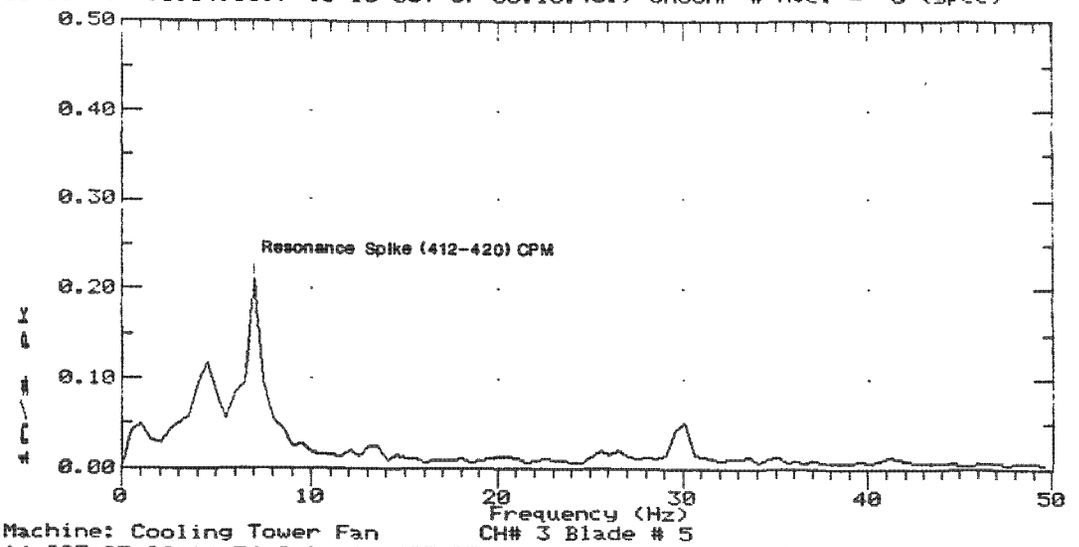
COMPANY : IPSC ENGINEERING
PLANT : UNIT 1
JOB REFERENCE: Cooling Tower Fans
MACHINE TRAIN: 1A03 Clg Twr Fan

PLOT No._____

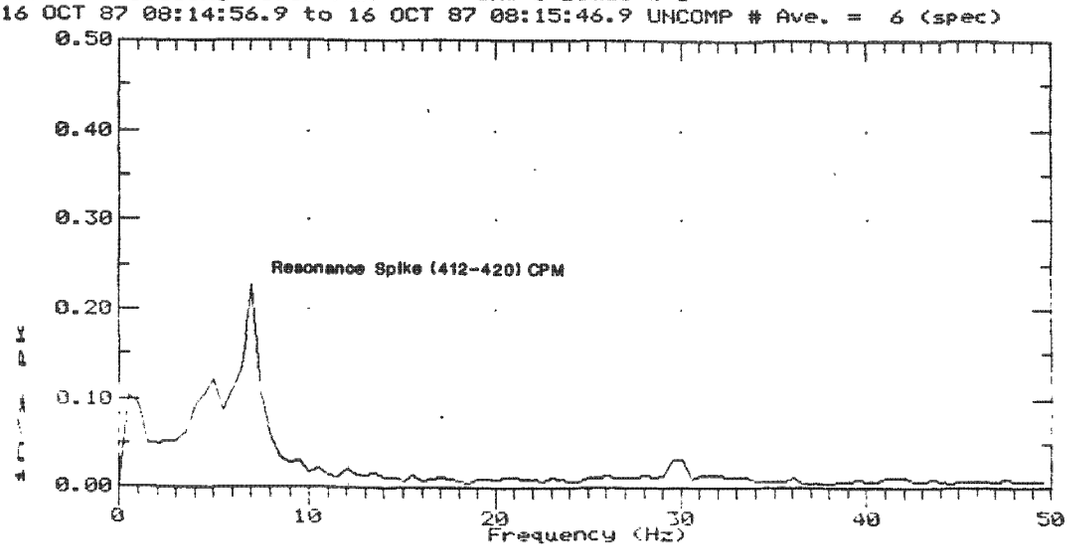
Machine: Cooling Tower Fan CH# 1 Blade # 1
16 OCT 87 08:14:26.9 to 16 OCT 87 08:15:46.9 UNCOMP # Ave. = 9 (spec)



Machine: Cooling Tower Fan CH# 1 Blade # 3
16 OCT 87 08:14:56.9 to 16 OCT 87 08:15:46.9 UNCOMP # Ave. = 6 (spec)



Machine: Cooling Tower Fan CH# 3 Blade # 5
16 OCT 87 08:14:56.9 to 16 OCT 87 08:15:46.9 UNCOMP # Ave. = 6 (spec)



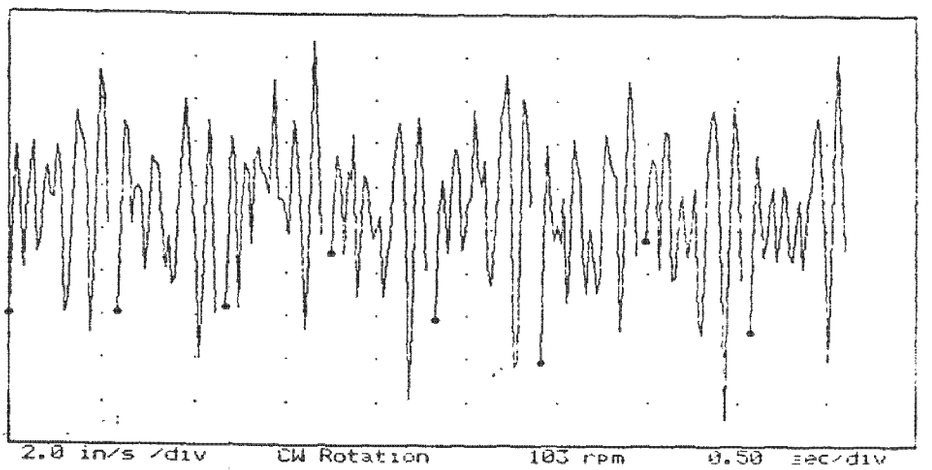
IP12_011545

ATTACHMENT # 2

COMPANY : IPSC ENGINEERING
PLANT : UNIT 1
JOB REFERENCE: Cooling Tower Fans
MACHINE TRAIN: 1A03 Clg Twr Fan

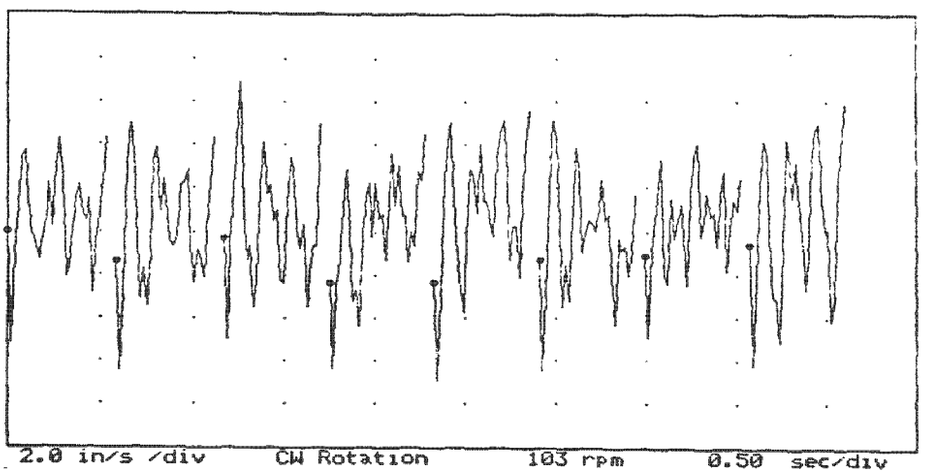
PLOT No._____

Machine: Cooling Tower Fan CH# 1 Blade # 1
16 OCT 87 08:20:49.8 Steady State UNCOMP

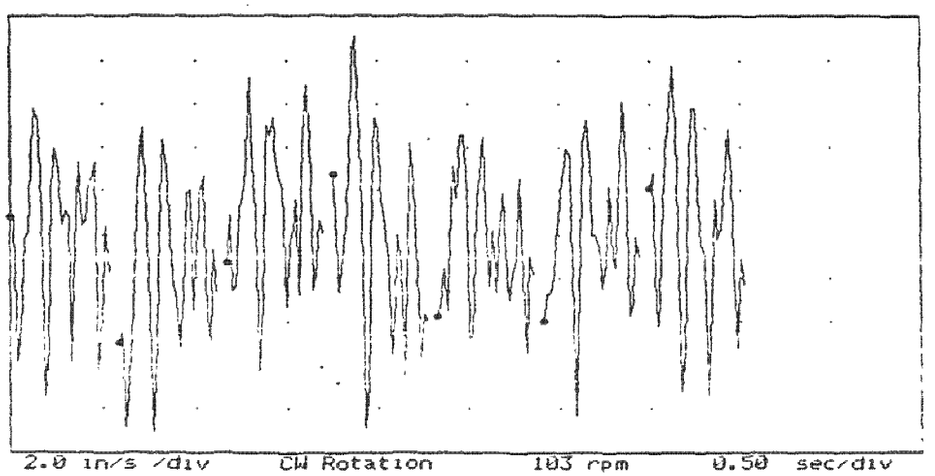


Machine: Cooling Tower Fan CH# 2 Blade # 3
16 OCT 87 08:20:49.8 Steady State UNCOMP

MULTIPLY X 10



Machine: Cooling Tower Fan CH# 3 Blade # 5
16 OCT 87 08:20:49.8 Steady State UNCOMP

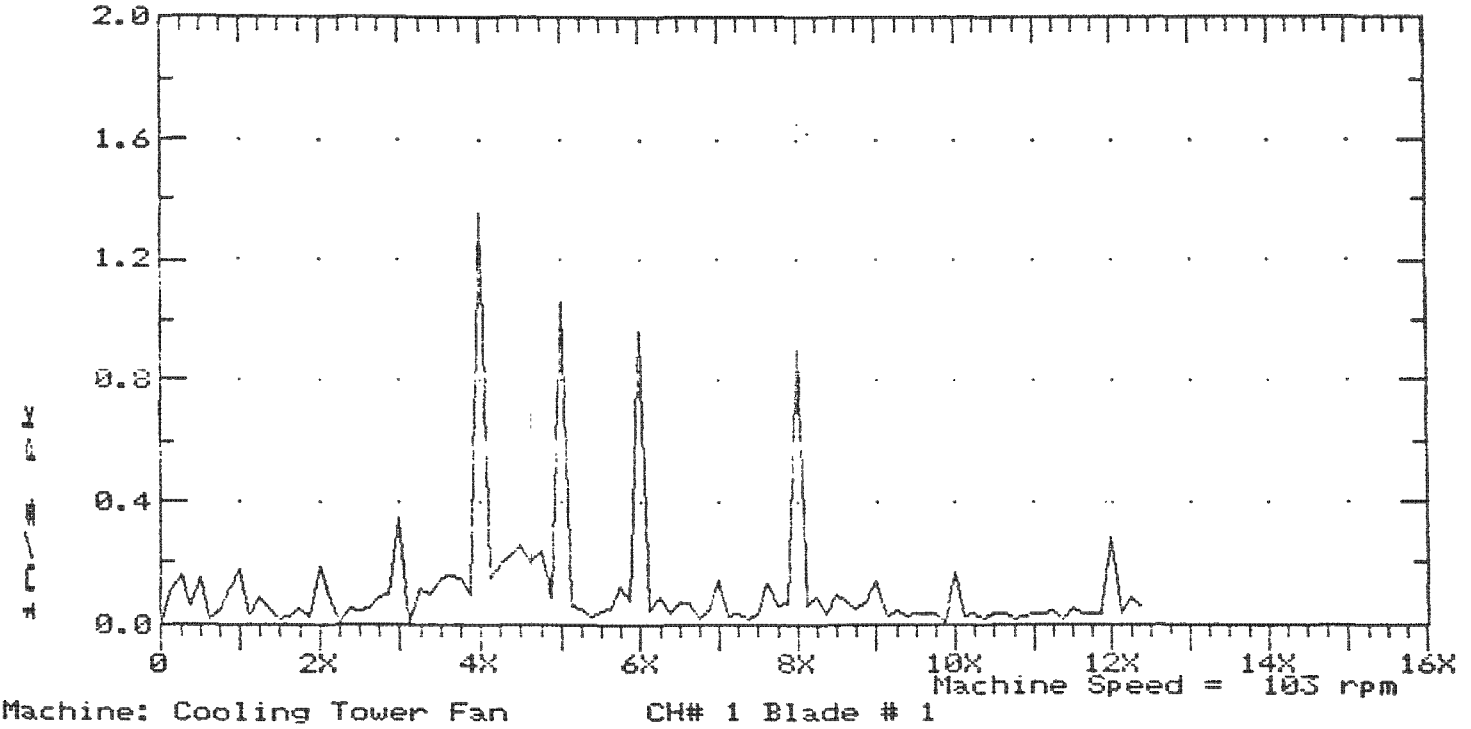


ATTACHMENT # 3

COMPANY : IPSC ENGINEERING
PLANT : UNIT 1
JOB REFERENCE: Cooling Tower Fans
MACHINE TRAIN: 1A03 Clg Twr Fan

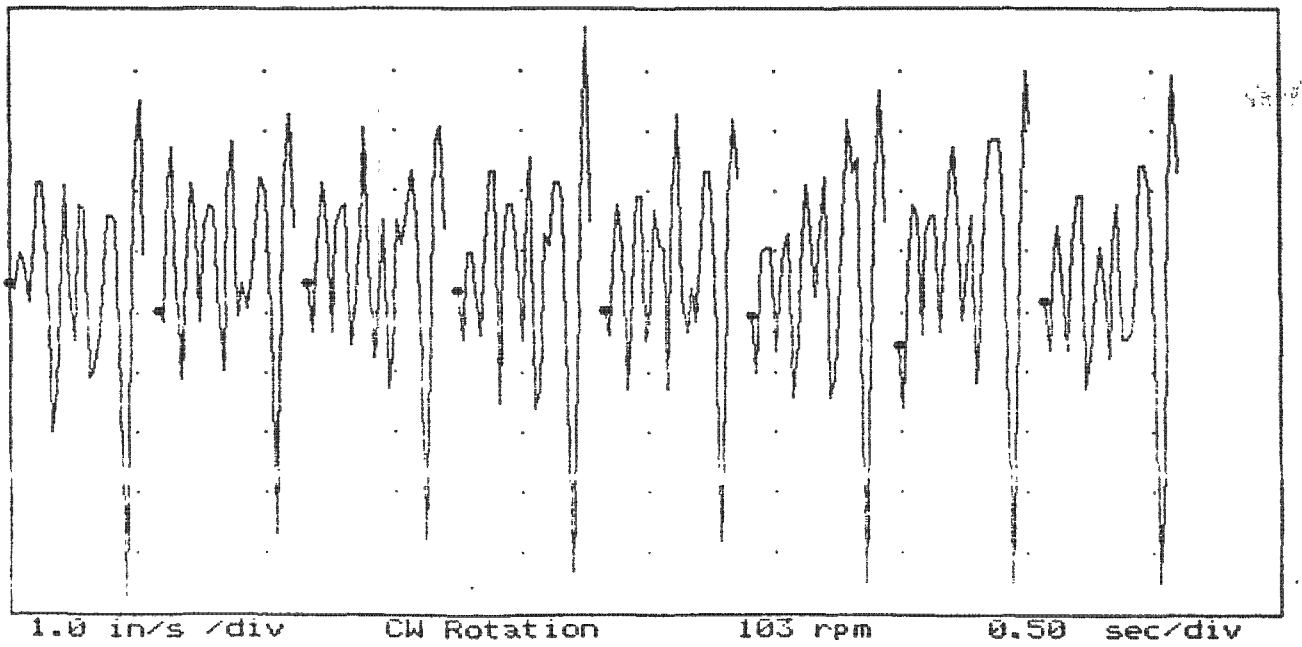
PLOT No._____

Machine: Cooling Tower Fan CH# 1 Blade # 1
16 OCT 87 08:23:29.8 UNCOMP



MULTIPLY X 10

Machine: Cooling Tower Fan CH# 1 Blade # 1
16 OCT 87 08:23:29.8 Steady State UNCOMP



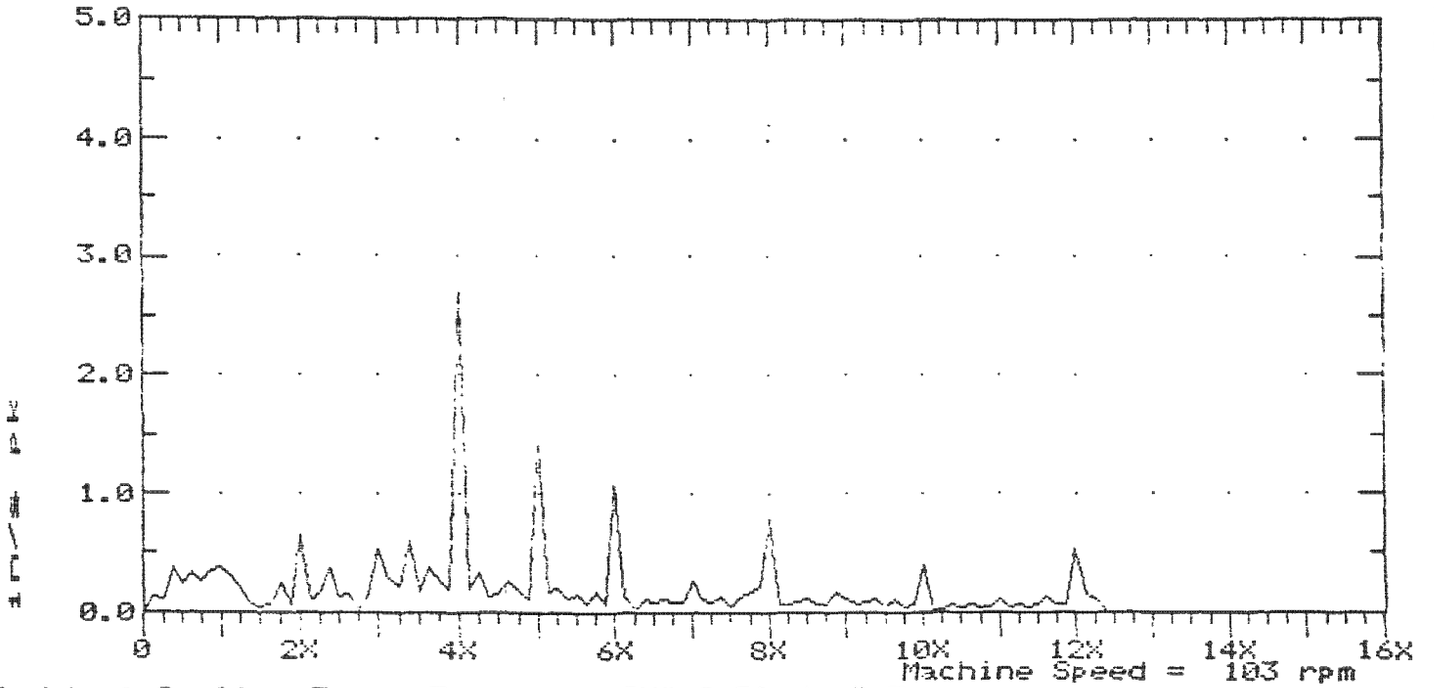
IP12_011547

ATTACHMENT # 4

COMPANY : IPSC ENGINEERING
PLANT : UNIT 1
JOB REFERENCE: Cooling Tower Fans
MACHINE TRAIN: 1A03 Clg Twr Fan

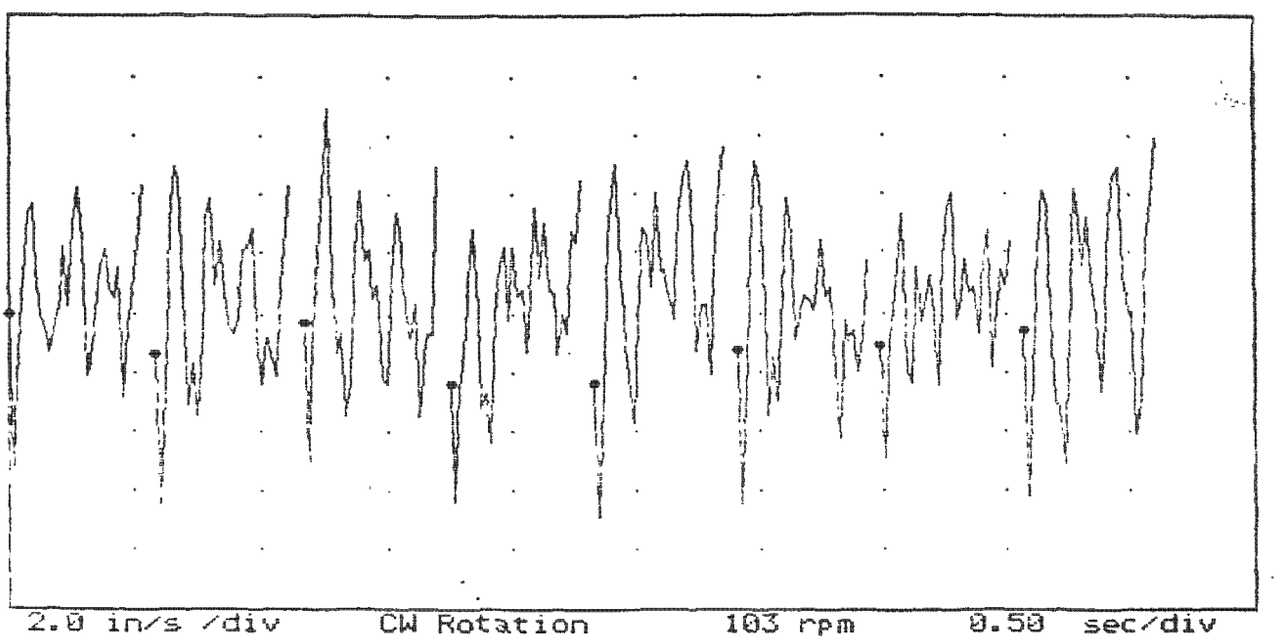
PLOT No._____

Machine: Cooling Tower Fan CH# 2 Blade # 3
16 OCT 87 08:20:49.8 UNCOMP



MULTIPLY X 10

Machine: Cooling Tower Fan CH# 2 Blade # 3
16 OCT 87 08:20:49.8 Steady State UNCOMP



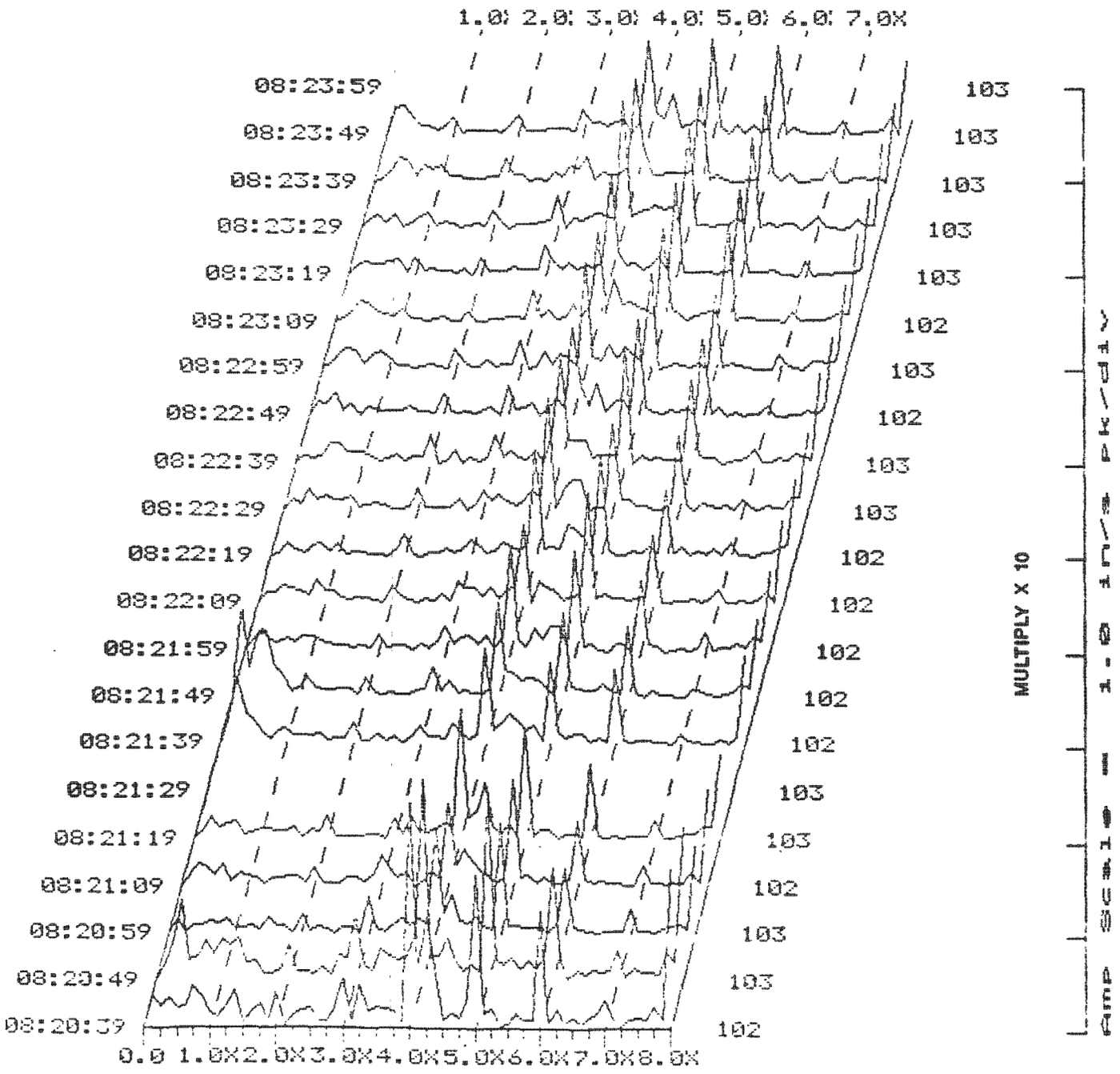
IP12_011548

ATTACHMENT # 5

COMPANY : IPSC ENGINEERING
PLANT : UNIT 1
JOB REFERENCE: Cooling Tower Fans
MACHINE TRAIN: 1A03 Clg Twr Fan

PLOT No._____

MACHINE: Cooling Tower Fan CH# 1 Blade # 1
16 OCT 87 08:20:39.8 to 16 OCT 87 08:23:59.8 Steady State UNCOMP

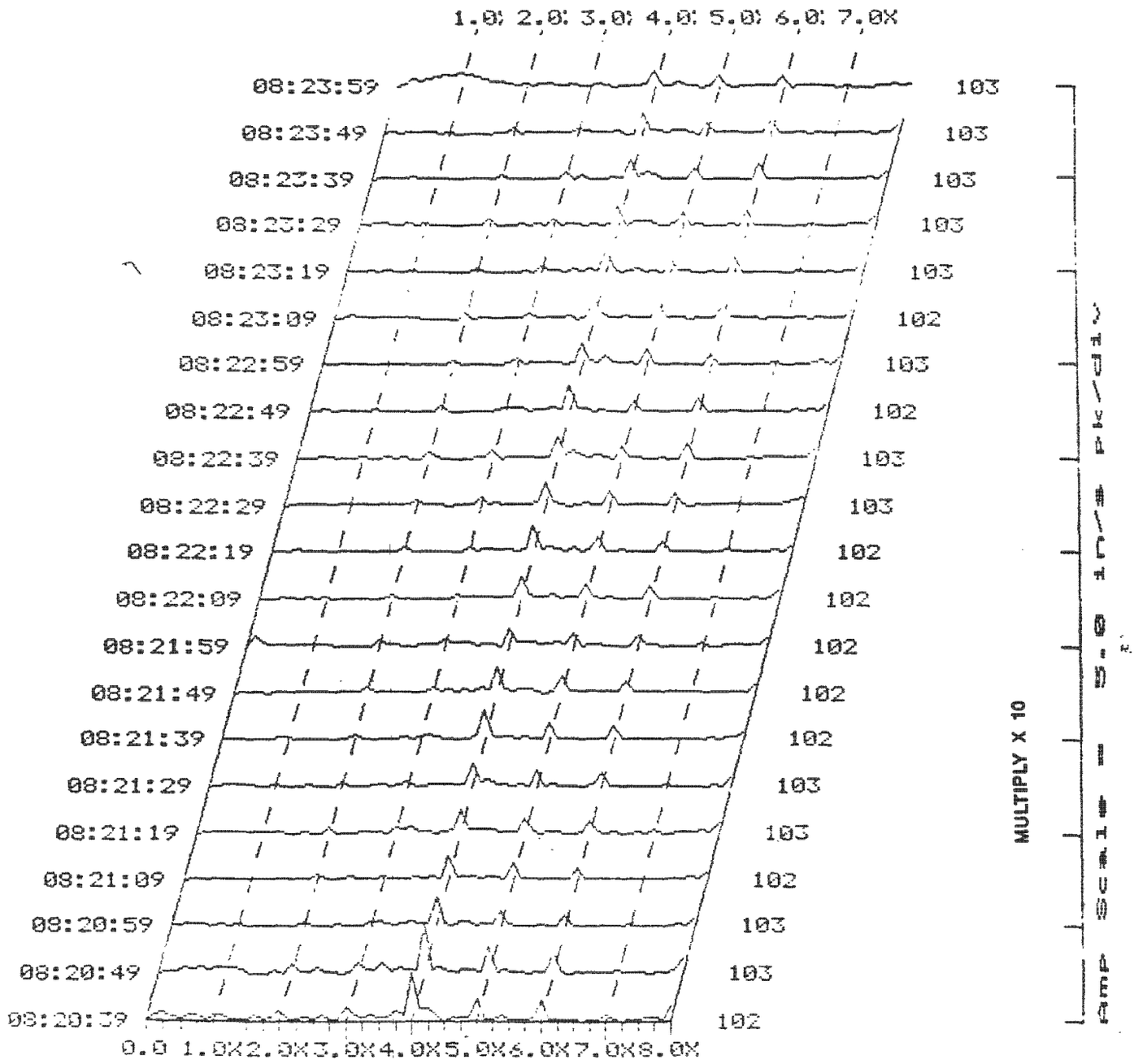


ATTACHMENT # 6

COMPANY : IPSC ENGINEERING
PLANT : UNIT 1
JOB REFERENCE: Cooling Tower Fans
MACHINE TRAIN: 1A03 Clg Twr Fan

PLOT No._____

MACHINE: Cooling Tower Fan CH# 2 Blade # 3
16 OCT 87 08:20:39.8 to 16 OCT 87 08:23:59.8 Steady State UNCOMP



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